TECHNICAL PROPOSAL

25X1 [redacted]

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FEASIBILITY STUDY
WATER EFFLUENTS IDENTIFICATION

25X1

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CONTENTS

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1. SUMMARY

This document describes a proposal for the conduct of a comprehensive study of the feasibility of a unique method for detecting, identifying, and assessing the activity of industrial plants.

25X1 The [redacted] proposes to study the possible applications of an aerial reconnaissance system to detect and identify waterborne industrial wastes, and from such identification, to locate, identify, and assess the activity of the plant or plants that are their source.

The system appears to have an extremely high potential as a strategic intelligence collection tool because it may make possible the location and identification of camouflaged, underground, or previously unknown industrial plants in foreign countries.

The principal methodology to be investigated is the detection and identification, from data collected by airborne remote sensors and/or by personnel on the ground, of industrial wastes discharged into rivers, lakes, or other bodies of water.

Water-borne wastes may sometimes be detected many miles from their point of entry into the receiving waters. Some types of wastes can probably be detected and/or identified only by chemical tests. Other types may be detected and/or identified from remote sensor records. Often, the point at which wastes are discharged into a body of water can be detected on remote sensor records.

The proposed study will investigate the theoretical, and then the practical, use of remote sensors (aerial photography, infrared detectors, radiation detectors, and possibly others) for this purpose. The study will determine what types of wastes are associated with specific industries, what the physical and chemical characteristics of these wastes are, and what remote sensors have the capability to record data from which the wastes can be detected and identified.

2. INTRODUCTION

The detection and identification of industrial wastes being discharged into streams, lakes, and other bodies of water may lead to the detection, location, and identification of their source, and of the materials or products being refined, processed, or manufactured.

Determination of the quantity of wastes being discharged may be an indicator of the level of activity of the source. This is particularly true if variations in quantity with time can be measured. It is noted, however, that the effectiveness of the source's waste treatment processes may have an important bearing on the validity of an assessment of activity by this means.

The feasibility of a combined aerial and ground reconnaissance system for this purpose is indicated by the results of much work that has been done by water conservation agencies and others. The following are examples.

Heated coolant water can be detected photographically after discharge into lakes and streams because it induces physical, chemical, and biological changes in the receiving waters.

If repetitive cover of an industrial plant which utilizes water for cooling is available, variations which are observed in the receiving waters may be a reliable indicator of activity level. Infrared and radiometric detectors may also be valuable for assessment of physical, chemical and biological changes in receiving waters.

The presence of certain wastes in water can be detected many miles from their point of entry. A few years ago, for example, a phenol "spill" occurred in Cleveland, Ohio. The presence of this phenol was detected as it progressed through Lake Erie, over Niagara Falls, through Lake Ontario, and into the Thousand Islands region of the St. Lawrence River. Similarly, radioactive substances (Sr^{90}, Co^{60}, Cs^{137}, Ru^{106}) have been detected in the bottom sediments

of the Clinch River in Tennessee, more than 20 miles from their point of release from the Oak Ridge National Laboratory.

Pollution effects such as fish kills have occurred several hundred miles downstream from the point of release of toxic substances into a river. Evidence exists which indicates that the tragic kills along the lower Mississippi were caused by substances introduced many miles upstream.

Evidences of pollution from mixed domestic and industrial sources can also be detected many miles downstream. The most obvious visible effects stem from increases in fertility of the water, and the effect on aquatic plants and algae.

Techniques for detecting the presence of various substances, particularly those substances which are known to be harmful to human life, have been used by investigators on the ground for several years. Most of the methods in current use for water supply and pollution control purposes are listed in "Standard Methods," a joint publication of the American Waterworks Association and the American Public Health Association. Additional analytical methods are listed in "Methods for Collection and Analysis of Water Samples," Geological Survey Water-Supply Paper 1454.

Attempts to adapt aerial reconnaissance techniques to pollution control investigations are relatively recent. The first known experimental work was conducted in 1954. This work has continued with many interesting and hopefully valuable findings. A leading expert in this field is now on the [redacted] 25X1

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While some use has been made of [redacted] in these efforts, most of the work has been directed toward the use of aerial photographic reconnaissance techniques. Black and white special film and filter combinations, color films, and camouflage detection film using the normal filters (Wratten 12 and 15) and non-standard filters to obtain special effects, have been employed. 25X1

The major purpose of these research efforts has been to develop methods which will aid pollution control authorities to detect critical water pollution conditions before human lives are lost. Considerable background knowledge has been acquired, however, which can be directly applied to strategic intelligence requirements.

3. STATEMENT OF THE PROBLEM

Strategic intelligence requirements necessitate the acquisition of information about the location, identity, and activity of foreign industries engaged in, or capable of, manufacturing weapons and other military materiel.

Major emphasis has been given in recent years to the acquisition of intelligence about foreign nuclear capabilities. Knowledge about the capability and active efforts of foreign powers to produce chemical and biological warfare agents is equally critical, but collection efforts in this field have been less intense than in the nuclear warfare field. Information about iron and steel production, general chemical processing, and petroleum production and refining is also needed.

25X1 [redacted] believes that much vital intelligence concerning foreign industrial activity can be obtained by the identification of specific waste materials discharged into rivers, lakes, and other bodies of water. There apparently has been little or no concerted effort on the part of government agencies or private investigators to identify, by analysis of waterborne wastes, the types of products being made or the materials being processed by an industry.

25X1 [redacted] proposes to explore the possibility of filling this void in the strategic intelligence collection process by conducting a study of the literature and by an experimental project, as outlined in the following paragraphs.

4. TECHNICAL APPROACH

Water pollution analysis is being accomplished today primarily to detect and prevent pollution for the protection of down-stream users. [redacted] 25X1 postulates that these techniques, plus certain aerial reconnaissance techniques, can be used also to locate, identify, and assess the activity of the industrial sources of such pollutants.

Water is an almost universal solvent. The presence in water of dissolved substances can be detected by qualitative chemical analysis. It is virtually impossible to remove all minerals from an ore, for example, using any of the presently available refining techniques. At least minor traces of the materials being removed from the ore will remain in any processing waters which are discharged as waste; their detection and identification can provide an important clue as to the identity of the plant responsible for their discharge. Similarly, the detection and identification of liquid effluents and of insoluble wastes can serve to identify the processes in which they are used.

The addition of foreign substances to water causes several physical effects, such as changes in temperature, density, viscosity, surface tension, clarity, and color. Obviously, these effects may be complex. A change in temperature, for example, will also change the density, viscosity, and surface tension of water. The addition to water of dissolved gasses, free ions, or other materials may also have a pronounced effect. Physical and chemical changes to the water may interact and cause biological changes to plants in, or irrigated by, the polluted water.

25X1 [redacted] believes that multisensor aerial reconnaissance techniques may permit a logical inference to be made as to the general chemical content or the physical condition of polluted waters. It is suggested that certain sensors can record meaningful data on the inter-relationships of certain physical conditions, biological secondary effects, and observable indicators. Interpretation and analysis of these sensor records may make it possible to classify broadly the chemical content or quality of the water.

Certain physical conditions, such as temperature and changes in transmissivity, can be detected and measured [redacted] 25X1

Aerial photographs, especially if they are obtained with carefully selected combinations of films and filters, can record images of such indicators as slick patterns, changes in wave form and aspect, color, turbidity patterns, schlieren, biological secondary effects (primarily thallophytic) induced by chemical and thermal variations, and the more obvious indicators--foams, oils, sludges, trash, fish kills. Any of these, singly or in combination, may be extremely useful in identifying pollutants in the water and in locating and identifying the source of the pollutants.

The detection of discharge points (possibly from underground or camouflaged industries) should be relatively simple in the case of rivers. If discernible currents exist in a lake, or in the ocean, "upstream" reconnaissance may also enable the detection of discharge points into these receiving waters.

In summation, it is proposed to study the nature of wastes discharged into water by various industries and to determine which aerial reconnaissance sensors, materials and interpretive techniques can be used to detect and identify such wastes, and to locate and identify their sources.

5. STUDY PLAN

25X1 [redacted] proposes to conduct the study in two phases. Phase I will be devoted initially to a search of the literature and discussions with such experts in the field of water pollution analysis and industrial waste processing as members of the National Technical Task Committee on Industrial Water, and industrial wastes research personnel at Purdue University and at the R. A. Taft Sanitary Engineering Center, Cincinnati, Ohio. These discussions and the results of the literature search will provide guidance for a theoretical evaluation of the feasibility of the proposed reconnaissance system.

Phase I will include nine tasks. These are:

Task I-1: Determine and catalog the types and volumes of wastes associated with various industrial operations in the United States and in selected foreign countries as reported in the available literature.

Task I-2: Categorize the physical and chemical nature of the wastes cataloged in Task I-1 as related to the types of products or materials that are manufactured or processed by the various industries.

Task I-3: Review the waste treatment practices associated with the various industries.

Task I-4: Determine the concentrations of residual or other indicator substances that are related to specific industrial products.

Task I-5: Catalog the physical, chemical, and biological effects of specific wastes on fresh, marine, and esturine waters.

Task I-6: Using appropriate non-airborne spectral measuring instruments, obtain spectral reflectance and emissivity values from different types of concentrated critical effluents. Obtain similar data on the effects of adding these effluents to water in reduced concentrations. This task will necessitate

the use of laboratory and field pilot facilities for simulation of conditions in a natural environment. When the best type of available facility for obtaining reliable measurements has been located, specific permission will have to be obtained to utilize the facility. A contract amendment will be required to fund this portion of the study.

Task I-7: Investigate the optimum sensitivity ranges desired in airborne sensors to enable them to detect specific critical substances or physical conditions in water. The object of this subtask is to define the optimum sensor capabilities for waste effluent analyses.

Task I-8: Evaluate the spectral and absolute sensitivity capabilities of aerial photographic systems as they affect the ability of the systems to image significant signature conditions in water. This subtask will include the testing and evaluation of multiband and spectrazonal photography for this purpose.

Task I-9: Test and evaluate the capabilities of various special sensors (infrared detectors, side-looking radar, radiation detectors) to detect critical substances in effluents and the receiving waters.

25X1 [redacted] will submit monthly progress reports and an Interim Final Report upon the completion of Phase I. It is expected that the data collected and evaluated during Phase I will provide a firm basis for the Phase II experiments. The data will also provide the government with background material that may have broad intelligence significance of immediate operational value.

Phase II of the proposed study will involve tests and evaluations of the operational uses of various airborne remote sensors to collect the necessary information and of methods for interpreting and analyzing the data. This phase will involve two tasks, as follows:

25X1 Task II-1: [redacted] will acquire, or be provided with, sensor data obtained by reconnaissance flights over selected industrial sites; the data will be obtained with photography, infrared detectors, radar, and 25X1 radiation detectors. [redacted] will obtain ground truth data concurrently with the flight operations.

Task II-2: This task will be accomplished concurrently with Task II-1. 25X1 [redacted] will interpret and collate the collected data and evaluate the effectiveness of each remote sensor in providing information from which industrial production and plants can be identified and their activity assessed.

25X1 [redacted] will prepare and submit monthly progress reports, and a Final Report upon completion of Phase II. It is expected that the Final Report will include conclusions and recommendations as to which types of remote sensors and recording materials or devices, and what methods of data reduction and correlation, will permit the detection, location, identification, and assessment of specified industrial activities.

6. PROGRAM ORGANIZATION AND MANAGEMENT

The proposed study will be conducted by the [redacted] 25X1

25X1 [redacted] The Center will assign a Senior Engineer to the project as chief investigator. He will be assisted by engineers and technicians skilled in the interpretation and analysis of multi-sensor imagery and data records, photographic technicians, and clerical personnel. He will

25X1 receive additional support from [redacted] experts in photometry, colorimetry, spectrography, chemistry, photogeology, multiband and spectrazonal photography, and related disciplines.

25X1 [redacted] will obtain the services of consultants in the fields of water pollution and industrial wastes during both phases of the study.

The laboratory experiments described in Task I-6, and the collection of ground truth as proposed under Task II-1, will require [redacted] to employ field 25X1 parties for varying periods of time.

It is estimated that Phase I can be accomplished in approximately eight (8) calendar months. Because of anticipated difficulties and delays in obtaining the reconnaissance data required under Task II-2, it is estimated that Phase II will require six (6) calendar months for completion. It is proposed that Phase I be initiated immediately upon receipt of authority to proceed, and that Phase II be initiated as soon as the recommendations resulting from Phase I have been approved by the government and [redacted] is authorized to proceed. 25X1

7. PROPOSED STATEMENT OF WORK

1. GENERAL

1.1 The contractor will conduct a comprehensive study of the feasibility of using multi-sensor aerial reconnaissance methods to detect, identify, and measure water-borne industrial wastes, and thus to identify, locate, and assess the activity of the sources of such wastes.

1.2 The study will be conducted in two phases. Phase I will consist of a comprehensive study of the literature on water pollution, industrial waste treatment, and related subjects; discussions with experts in these fields; and a theoretical evaluation of the feasibility of employing aerial reconnaissance for the purposes stated in 1.1. Phase II will extend from Phase I. It will, as appropriate, involve tests and evaluations of the operational uses of various remote sensors to collect the necessary information, and of methods for interpreting or analyzing the sensor records.

2. PHASE I

2.1 The contractor will conduct a comprehensive search of the literature on water pollution, industrial waste treatment, and related subjects. He will hold discussions with experts in these fields. Based on this literature search, and on the discussions, he will perform the following tasks:

2.1.1 Task I-1: Determine and catalog the types and volumes of wastes associated with various industrial operations in the United States and in selected foreign countries, as recorded in the literature.

2.1.2 Task I-2: Categorize the physical and chemical nature of the wastes cataloged in Task I-1, as they are related to the types of products or materials that are produced or processed by the various industries.

2.1.3 Task I-3: Review the waste treatment practices associated with the various industries.

2.1.4 Task I-4: Determine the concentrations of residual or other indicator substances that are related to specific industrial products.

2.1.5 Task I-5: Catalog the physical, chemical, and biological effects of specific wastes on fresh, marine, and esturine waters.

2.1.6 Task I-6: Determine and define the requirements for laboratory and/or field facilities required to obtain, under a simulated natural environment, (a) spectral reflectance and emissivity values of different types of undissolved concentrated critical effluents using non-airborne spectral measuring instruments and (b) similar values reflecting the effect of adding such effluents to water in reduced concentrations. Arrange for and conduct the operations necessary to obtain these values.

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2.1.7 Task I-7: Using data provided by the government or obtained by the contractor, investigate the optimum sensitivity ranges desired in airborne remote sensors that will enable the sensors to detect specific critical substances or physical conditions in water.

2.1.8 Task I-8: Evaluate the spectral and absolute sensitivity characteristics and capabilities of aerial photographic systems, including multiband and spectrazonal systems, as they affect the ability of the systems to image significant signature conditions in water.

2.1.9 Task I-9: Test and evaluate the capabilities of various special sensors (infrared detectors, side-looking radar, radiation detectors, etc.) to detect critical substances in effluents and the receiving waters. This task will be performed using technical data and sensor records provided by the government, and/or obtained by the contractor.

2.2 The contractor will submit monthly progress reports during the prosecution of Phase I, and an Interim Final Report upon its completion. It is expected that the data collected and evaluated during Phase I will provide a firm basis for the formulation of recommendations for the conduct of Phase II. It is expected that the Contracting Officer or his Technical Representative will, on the basis of an evaluation of the monthly reports and the Interim Final Report, concur in or suggest modifications to such recommendations, and that this concurrence will provide the starting point for Phase II of the contract.

3. PHASE II

3.1 Upon receiving authority from the Contracting Officer to proceed with Phase II, the contractor will perform the following tasks:

3.1.1 Task II-1: Prepare specifications for aerial reconnaissance, to be performed by the government, of selected industrial sites or areas, using photography, infrared detectors, radar, radiation detectors, or other sensors in accordance with approved recommendations that resulted from Phase I. Obtain ground truth data concurrently with the aerial reconnaissance operations, for use in evaluating and correlating the data obtained from the air.

3.1.2 Interpret and collate the data obtained by the aerial reconnaissance operations and the ground reconnaissance operations. Evaluate the effectiveness of each of the remote sensors in providing information from which industrial production and plants can be identified and their activity assessed.

3.2 The contractor will provide monthly progress reports during the prosecution of Phase II, and a Final Report upon its conclusion. It is expected that the final report will include conclusions and recommendations as to which types of remote sensors and recording materials or devices, and what methods of data reduction and correlation, will permit the detection, location, identification,

and assessment of specified industrial activities from the identification of water-borne wastes they discharge.

4. REPORTS

4.1 The contractor will submit monthly progress reports during both phases of this contract. These reports will be submitted on or before the 20th calendar day following the end of the contract month.

4.2 The contractor will submit an Interim Final Report within 60 days following completion of the tasks enumerated in paragraph 2.1.

4.3 The contractor will submit a Final Report within 60 days following the completion of the tasks enumerated in paragraph 3.1.

4.4 Reports will be submitted in ten copies.

5. GOVERNMENT FURNISHED EQUIPMENT AND MATERIALS

5.1 Certain of the tasks in Phase I and Phase II require the contractor to evaluate existing sensors, and to acquire sensor records obtained during aerial reconnaissance over selected industrial sites and areas. The Government will provide, as GFE, data on and records obtained by sensors that are protected by a security classification, or that are unavailable through normal channels for other reasons (such as the proprietary nature of certain sensors or devices). Materials so provided will be used only for the purposes of this study, and will be returned to the government (or disposed of as directed by the Contracting Officer) upon the completion of this contract.

5.2 The government will arrange for and conduct the aerial reconnaissance operations described in paragraph 3.1.1. The sensor records obtained by such reconnaissance will be provided to the contractor for the purposes of this study, and will be disposed of in accordance with instructions from the Contracting Officer upon completion of the contract.

6. SUBCONTRACTS

6.1 The contractor will obtain the services of consultants in the fields of water pollution, industrial waste processing, and related disciplines as necessary in the prosecution of Phase I and Phase II of this contract, subject to approval by the Contracting Officer.

6.2 The contractor will employ field parties as necessary to obtain ground truth data (paragraph 3.1.1) and to perform the tests and experiments described in paragraph 2.1.6.

6.3 The contractor will arrange for the use of field or laboratory facilities required to obtain the data described in paragraph 2.1.6.

7. PERFORMANCE

7.1 The contractor shall provide the necessary labor, services, facilities, materials, and equipment, except as described in paragraph 5, and will exert his best efforts to conduct a study of the feasibility of Aerial Reconnaissance for the Detection and Identification of Industrial Plants through the Detection and Identification of their Water-borne Industrial Wastes.

7.2 The study will be conducted in two phases. Phase I will be completed in approximately eight calendar months. Phase II will be completed in approximately six calendar months. Phase I will commence upon receipt by the Contractor of authority to proceed. Phase II will commence after the government has concurred in, or modified, the Interim Final Report to be submitted by the contractor upon the completion of Phase I, and has authorized the Contractor to proceed with Phase II.

Next 3 Page(s) In Document Exempt

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